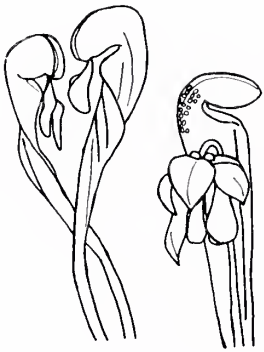
CARNIVOROUS PLANT NEWSLETTER

VOLUME 18, Number 1 MARCH 1989



CARNIVOROUS PLANT NEWSLETTER

Official Journal of the
International Carnivorous
Plant Society

Volume 18, Number 1
March 1989

Front cover: *Utricalaria campbelliana*. See article beginning on page 15.

The co-editors of CPN would like everyone to pay particular attention to the following policies regarding your dues to the ICPS.

All correspondence regarding dues, address changes and missing issues should be sent to ICPS c/o Fullerton Arboretum, CSUF, Fullerton, CA 92634. DO NOT SEND TO THE CO-EDITORS. Checks for subscriptions and reprints should be made payable to ICPS.

All material for publication, comments and general correspondence about your plants, field trips or special noteworthy events relating to CP should be directed to one of the co-editors. We are interested in all news related to carnivorous plants and rely on the membership to supply us with this information so that we can share it with others.

Views expressed in this publication are those of the authors, not necessarily the editorial staff.

Copy deadline for the September 1989 issue is July 1, 1989.

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see pp. 7 & 15

SEED BANK

by Patrick Dwyer
35 Culver Ave., Albany, NY 12205

Starting with this issue of C.P.N., there will be a new service related to the seed bank available.

With the help of Patrick Dwyer, I will be making available a monthly update of the seed bank inventory to any interested members. This will enable members to obtain seed while it's still at it's freshest, and hopefully ease the burden on Patrick caused by mass seed orders every three or four months.

The seed bank listings will continue to be run in each issue of C.P.N., and all seed orders and donations should still be sent to Patrick Dwyer.

Any members interested in obtaining the update should send their request to, Gordon C. Snelling; 329½ W. Palm Ave.; Monrovia, California 91016.

Please include a S.A.S.E. or return postage with your request, overseas members please include two international reply coupons.

To send seed: Please remove seed from the seed capsules and place it in small envelopes (preferably paper so that they dry out enough to prevent mold). Label with the origin and date of collection, including habitat if it is exotic. Fold the envelope once or twice before taping so that the seeds don't stick to the tape. After the seed is received it will be placed in smaller packets; donors will be informed of how many packets they have donated. A donation of 10-19 packets earns one free seed packet of comparable rarity, with one additional free packet for each additional 10 packets.

Do not ask to trade for seed from the bank. Everyone will have to buy all but the free packets.

To order seed: Please enclose payment. List the seeds desired and an equal number of substitutes in order of preference. If requested, Patrick will add any cultural instructions of which he is aware. Each issue of CPN will include an update of the inventory. Cost per packet: $.75. (Number of packets is listed if less than 15 are available.)

ICPS SEED LIST

12/22/88

Starting with this list, general collection localities will be listed where a species is found over a large area. If nothing is listed assume that it is from **cultivated** plants.

Byblis liniflora (10); *Capsella bursa-pastoris* (non CP); *Dionaea muscipula; Dionaea muscipula* (Burgandy trap) (10); *Drosera aliciae; D. anglica* (Yukon, Canada); *D. arcturi* (15); *D. binata* (3); *D. binata multifida* (1); *D. brevifolia* (5); *D. burkeana* (9); *D. burmannii; D. capensis; D. capensis* (narrow leaf); *D. capillaris; D. capillaris* (Gulf Coast Giant) (5); *D. dielsiana; D. erythrorhiza; D. filiformis filiformis; D. filiformis* "California sunset" (15); *D. glanduligera; D. intermedia; D. intermedia (S. Carolina); D. intermedia* (tropical); *D. lovellae* (10); *D. pygmaea* (5); *D. rotundifolia; D. rotundifolia* (British Columbia, Canada); *D. rotundifolia* (Czechoslovakia); *D. rotundifolia* (Lowland-Czechoslovakia); *D. spathulata* (Tanega) (2); *Drosophyllum lusitanicum* (15); *Pinguicula caudata* (5); *P. ionantha* (15); *P. lusitanicum* (2); *P. macroceras* (Yukon, Canada) (10); *P. primuliflora* (2); *Sarracenia alata; S. flava* (3); *S. flava* "typica"; *S. flava* "copper lid" (5); *S. leucophylla; S. minor* (10); *S. psittacina* (10); *S. purpurea purpurea* (5); *S. purpurea venosa* (1); *S. purpurea* "Louis Burke" (5); *S. rubra* (2); *S. rubra* (Gulf Coast) (5); *S. rubra gulfensis; S. rubra jonesii* (5); *S. rubra rubra; S. rubra wherryi; S. alata* x *minor* (2); *S.* x *areolata* (3); *S. (flava* x *purp)* x *(flava* x *purp)* (5); *S.* x *catesbaei* (3); *S. purp* x *psitt* (6); *S. oreo* x *leuco* (1); *S. flava* x *(alata* x *flava)* (4); *S. (oreo* x *purp)* x *rub. wherryi* (1); *S. (minor* x *oreo)* x *rub. alabamensis* (1); *S. rub. alabamensis* x *psitt* (1); *S. (leuco* x *rub. wherryi)* x *rub. alabamensis* (1); *S. rubra* x *(psitt* x *leuco)* (1); *S. (rub. jonesii* x *purp)* x *(purp* x *psitt)* (1); *S. (leuco* x *rub. wherryi)* x *(purp* x *psitt)* (1); *S. (purp* x *rubra x* psitt) x *rub. alabamensis* (1); *S. purp* x *psitt* (1); *S. (psitt* x *purp* x *minor)* x *rub wherryi* (2); *S. minor* x *rubra rubra* (2); *Utricularia pentadactyla* (5); *U. subulata* (3); *U. uliginosa.*

NEWS & VIEWS

Steve Ludlow, (8 Rowland Close, Copthorne, W. Sussex, RH10 3HT, England) writes about a observation of an unusual mode of propagation in *DIONAEA:*

Early this year one of the Flytraps which I used to keep on a south facing windowsill began to form a flowering stalk and I decided, despite the risk of weakening the plant, to let it develop. In due course the usual branching pattern appeared and it bloomed. The first flowers to open already had their petals rolled up and blackened by the time the last came out and it was at this time that I noticed a plantlet developing at the main point of stalk division. It had several leaves and even minute open traps (see photo).

By early May the whole of the flower stalk had blackened but the plantlet was healthy. It looked as if it might detach from the stalk in time but, fearing that it would perish, I gently removed it and potted it up. If this phenomenon occurs in nature perhaps rain, wind or the passage of animals would detach the plantlet.

I can find no reference to this mode of propagation in the literature I have (Slack, Cheers) and wonder how often it is observed in cultivation or in the wild.

JOE MAZRIMAS reports that in response to the wishes of Mr. Verdavaine, we now have a volunteer to do our comprehensive index for CPN. His name is Tim Topoleski from the University of Pennsylvania School of Engineering and Applied Science. He has computer resources at his disposal and sent us good examples of his work so that for the first time we will have an index we can be proud of. Upon completion of the master copy, the editors will make an announcement on how this index will be distributed.

BARRY MEYERS-RICE, Steward Observatory, University of Arizona, Tucson, AZ 85721 writes:

On a trip in late August of 1988, my wife and I spent two weeks in the Mexican resort of Puerto Vallarta, which is located in Jalisco State, part of Mexico's Pacific coast. Joe Mazrimas and Larry Mellichamp had informed me that my chances of seeing CPs in this part of Mexico were slim, but I hoped to beat the odds. As it was, they were right. However, the following information may prove useful to CPers that are vacationing in that part of Mexico as to what places have already been checked (if only by a nonprofessional with little experience). I concentrated on riverbank and surrounding areas for the following rivers, listed from most northern or more southern. After each river's name, I have included the number of miles upriver of the ocean, or the name of the

prominent feature to which the river was examined (in varying degrees of completeness). Rio Cuale (12 miles), Rio Tomatlan (10 miles), Rio Quimisto (to the Quimisto waterfalls), Rio Yelapa (to the Yelapa waterfall). Some of these rivers are somewhat industrialized over their lower parts, and are useless for CPs.

The local guides told us that while the present year was very moist, while the previous year was dryer. I have not verified this fact myself. Even though no CPs were sighted, the foliage on remote Mexican riverbanks is lush and varied, a sight worth seeing.

On a different subject, I have found an excellent material to use as a reflective surface. It's a thick mylar layer, heavily aluminized on one side. It's extremely reflective, easily cut with a razor, and excellent for taping to the back and sides of terrariums to minimize light losses. It sure beats foil, conventional mirrors or metal sheeting! You can buy this at most stores that sell aquariums, where it is used as a decorative backing on fish tanks. It's often chemically etched on one side with what smells like napthalene (mothballs), so I've usually aired it out for about a week before I tape it into place indoors. Use electrician's tape.

ALEXANDER MRKVICKA, Hopflergasse 6/16/1/4, A-1230 Wien, Tel. 86 18 992, Austria/Europe writes about thoughts concerning an additional labeling of local CP oecotypes for our seedbank:

In past years the ICPS-seedbank only labeled species and sub-species/varieties but, as I will show with some examples, it seems quite necessary to pay regard also to the geographical origin of CP seed purchased from our seedbank.

Some years ago, a friend who has been visiting the United States delivered me with various *Drosera, Pinguicula* and *Utricularia* seed or plantelets he had collected in the southern parts of the USA.

All the plants I raised from these material showed one peculiarity: They were not able to accommodate to the (shorter) Middle European growing season. *Drosera intermedia* from Florida began to grow at the same time as European origins of *Dros. intermedia,* but in autumn the rosettes were persisting about one month longer than the Europcan ones and were beginning to form hibernacula by end October while European plants had no green leaves left and th hibernacula fully developed. After great losses each winter I stopped cultivating many species (e.g. *Pinguicula vulgaris, Dros. intermedia, D. rotundifolia* and some *Utricularia)* originating from southern USA outdoors while I am still successful with the same species from Middle Europe.

Now my suggestion for an improved CP-seedback:

Try to label your CP-seed not only with the name(s) but also with the geographical origin of your plants if you know it, as there are much more local oecotypes of CP than you might think!

This would be no big inconvenience for you but would help all of us who want to use and select their CP for a special purpose like growing outdoors, etc.

Ed Note: Pat Dwyer will do this starting in this issue.

Alex sent in some comments about his outdoor bog in Austria that were printed in the June, 1988 CPN (Vol. 17, p. 38). He has now sent us pictures.

Figure 1 shows a portion of the bog with abundant living moss and plants of *Sarracenia purpurea ssp. purpurea* and some flowering *Dionaea* in the background. The small central pond is in one corner and is clear and dark with tannins. This photo was made in August, 1988.

Figure 2 shows the same general area and plants in March, just after the last snowfall has melted.

Figure 3 shows the whole outdoor bog which was established in 1982. The net around and over the bog helps prevent blackbirds which rob sphagnum for their sprind nests.

Alex still wishes to hear from other outdoor CP growing enthusiasts, especially in Europe.

See **FIGURES** on next page.

ALEXANDER MRKVICKA'S BOG

Fig. 1. Bog in August, 1988 with *Sarracenia purpurea* ssp. *purpurea*.

Fig. 2. Bog in March, 1988.

Fig. 3. Full view of Bog in August, 1988.

SARRACENIA PURPUREA IN WESTERN CANADA

by Randy Lamb
Suite #106, 5030 Hastings St.
Burnaby, B.C. V5B 1P6, Canada

The genus *Sarracenia,* distributed mainly in the Southeastern United States, has one species extending northwards to eastern Canada and beyond (Schnell 1976). During the retreat of the last continental ice sheet, 10 to 18,000 years ago, *Sarracenia purpurea* colonized the newly formed bogs extending it's range as far north as subarctic Canada and west across the boreal forest ranges to the Rocky Mountains. The northwestern limits of the species were uncertain until populations of *S. purpurea* were discovered in northeastern British Columbia (Annas 1977, Krajina 1968) and in the District of Mackenzie of the Northwest Territories (Cody 1973). The *S. purpurea* populations in British Columbia are the most western known today, occuring approximately 700 km (440 mi.) from the Pacific Ocean and within 540 km (340 mi.) of southern Alaska. These pitcher plant locations are actually further west longitudinally than Los Angeles and San Francisco. In 1973, shortly after these discoveries, an ecological reserve covering 259 hectares was created to protect one of the two known populations of *Sarracenia* in British Columbia (reserves ref. 1987). A reserve proposed for the second location has not yet been established.

The summer of 1988 held a work semester in the Yukon Territories for me where I worked as a field biologist involved with the infamous scourges of the north, mosquitos and blackflies realizing that my duties would be taking me into potential habitats of insectivorous plants, I spent the time prior to my departure obtaining maps and searching for literature on documented locations.

S. purpurea in habitat near Ft. Nelson, British Columbia, Canada. Note red tips of pitchers. Photos by author.

Closer view of *S. purpurea.*

I had the opportunity to visit the *Sarracenia* reserve during the weekend of July 9th, and even with maps of the area it proved to be difficult to find. After travelling to the end of a muddy unmarked road I proceeded on foot for approximately 2 km further through black spruce stands, dense shrubs, and sphagnum bogs. Between checking my compass, pulling myself out of soft areas in the bogs, watching for bears, and swatting at the cloud of mosquitos following me, I might have missed the pitcher plants entirely! Fortunately, their flowers were on scapes 20 to 30 cm tall making them immediately visible above the grasses. The plants were growing almost submerged in floating sphagnum mats that encircled a small lake, and occured with *Drosera anglica* and *D. rotundifolia.* Many plants had only the upper half of their pitchers above the water table, and the younger ones barely managed to remain uncovered by the sphagnum moss. Despite growing in full sun, the plants had only light venation on their bright green pitchers with some reddening of the hood tips. Many plants had put up 2 or 3 flowers each recently and most still had their petals intact despite the overall deep red colouring of the flower parts, the styles remained green with just the tips tinged in red.

The *Sarracenia* in the ecological reserve appeared to be doing quite well judging by the number of flowering plants and the presence of seedlings. I hope to explore the second known pitcher plant location in British Columbia in the future and perhaps obtain seed to introduce to other suitable habitats.

Selected References:

Annas, R.M. 1977. Boreal Ecosystems of the Fort Nelson Area of North Eastern British Columbia. PhD dissertation. University of British Columbia, Vancouver, British Columbia. p. 238-244.

Cody, W.J. & Talbot, S.S. 1973. The Pitcher Plant *Sarracenia purpurea L.* in the Northwestern Part of its Range. The Canadian Field Naturalist 87:318-320.

Guide to Ecological Reserves in British Columbia. 1987. Ministry of Environment and Parks. Victoria, British Columbia. p47a, b.

Krajina, V.J. 1968. *Sarraceniaceae,* a new family for British Columbia. Syesis 1:121-124.

Schnell, D.E. 1976. Carnivorous Plants of the United States and Canada. John F. Blair, Winston-Salem, North Carolina. 125 p.

Straley, G.B., Taylor, R.L. & Douglas, G.W. 1985. The Rare Vascular Plants of British Columbia. National Museums of Canada. Syllogeus no. 59.

CP UNDER YOUR MICROSCOPE

by Alex Mrkvicka
(Hopflerg. 6/16/4, A-1230, Vienna)

You are growing your CP for your pleasure only; you like that extraordinary looks and habits? You don't like all the botanical delicacies like plucking marvelous flowers to pieces and counting the remains? Then this article will be the right inspiration for you! I do not want to show you exact botanieal details, but I want you to see the perfection of even the most minute cells of your plants.

Now let us start the show. Bribe your children to lend you their microscope (which lies unused in a cupboard in their room) for a while, pinch some clear nail-polish, a new razor-blade (electrical shavers are **not** suitable!) and tweezers from the bathroom and you are ready.

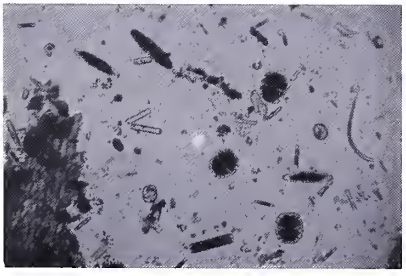
- Take a piece of *Sphagnum* and press it between your fingers until a drop of water appears and take a look at the inhabitants of it through the microscope with about 100 enlargement. By increasing the enlargement you will see the most pantastic-shaped microorganism (Slides 1, 2; if you could obtain some *Sphagnum* from a bog, there would be even more delightful forms!).
- Pull off a leaf of *Sphagnum* and look at the ingenious structure of the water-storing cells (Slide 3).

Now, after the first steps we begin to slaughter our CP:

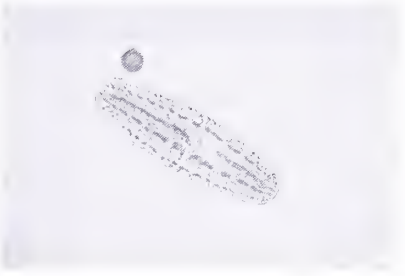
- Cut some gland-hairs of *Drosera* and look at them (in a drop of water) through the lenses (Slides 4, 5) or
- Cut an old pitcher of *Sarracenia*/*Nepenthes* and try to eut out some thin pieces (with the razor blade) of the pitcher rim, hood, inside . . . (Slides 7-9 show *Sarracenia leuco* x *oreo*) and you will observe the most wonderful and tricky details, you've never seen before.
- If you want to see the patterns of the epidermal cells spread some clear nail-polish over the leaf surface and pull it off when it has dried. You will be able to see the impressions of cells, glands and hairs of the pitcher surface (Slide 6).
- When cutting the pitchers in transverse direction you will observe the bigger cells forming the veins situated in semi-circles (especially when dyed with methylene-blue).

If you are in the possession of a stereoscope, you could even dispense with pins and razor-blades and see also the hidden secrets of *Dionaea!*

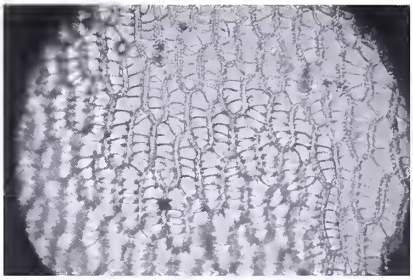
And now it is your turn to find other interesting objects (I would suppose *Utricularia, Genlisea, Polypompholyx* and pollen grains!) among your CP and prepare them in a suitable manner. (But try to leave some leaves on your plants in spite of your enthusiasm!)!



Slide 1:
Some inhabitants of living *Sphagnum* (100).

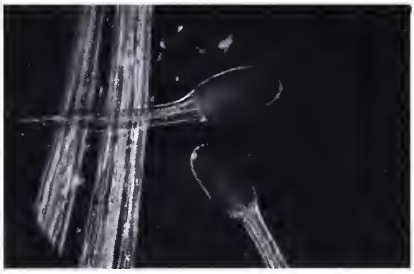


Slide 2:
One of them at 1000.

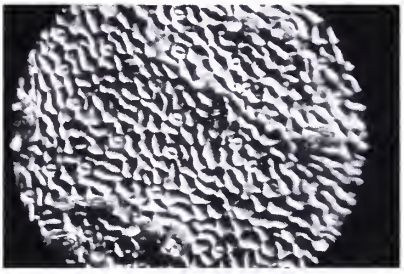


Slide 3:
A part of *Sphagnum*-leaf (note the huge water-cells between the living, green cells!) (400).

Slide 4:
Intact head of one *Drosera* gland-hair (200).

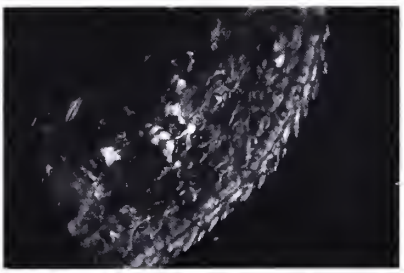


Slide 5:
Two of them shortly after digestion (200).



Slide 6:
Impression of the outer epidermis of *Sarracenia leuco* x *oreo* made with nail-polish (100).

Slide 7:
Vertical section through the pitcher rim of the same, note the tapered, downward pointing cells on the inner regions of the rim (50).



Slide 8:
The same section at 200.

Slide 9:
Stiff, pinlike hairs of the digestive zone inside the pitcher (pointing to the bottom of the pitcher) (200).

PROPAGATING *DROSERA DILATO-PETIOLARIS*

by Curtis Yax
233 Chestnut St., Oneonta, NY 13820

During the fall of 1984, I had the good fortune of receiving several healthy specimens of *D. dilato-petiolaris*, a plant long considered to be a form or variety of *D. petiolaris*. Dr. Kondo of Japan conducted extensive research classifying and naming this exciting new species from tropical Australia, along with two other distinct taxa, *D. falconeri* and *D. lanata* which were also considered variants of *D. petiolaris*.

The very rare *D. dilato-petiolaris* is beautifully portrayed in a painting created by Mrs. Rica Erickson from her book Plants of Prey.

The plants I cultivated were vigorous growers producing many flowers the first year. None of these flowers produced seed and unlike most sundews, leaf or root cuttings proved ineffective. They produced offshoots and many divisions were made for trading during the next couple of years. The plants, however, were being disturbed so often that many of them began to die. This year I was left with one plant and this one started to rot and die!

I made a last ditch effort to save the species and quickly took off all the remaining leaves by pulling them off one by one making sure that the whitish base was included. This was done by hand and not by cutting with a razor or scissors and thereby reducing the chance of rot.

Since I had excellent results producing plants from the base of *Pinguicula* leaves, I decided to try the following method with *D. dilato-petiolaris*. This method also works best with *Drosera* hibernacula, which produce plants liberally from their separated leaf buds. I used a 2 inch pygmy terrarium with tape covering the holes on top so that there was a 100% humidity level constantly maintained. A lower humidity level inhibits growth. On the bottom of the tiny terrarium I placed some live sphagnum moss and placed the leaves on the surface. The leaves were then covered with more live moss and gently firmed. The use of live moss is best since it inhibits algae and fungus growth. The plastic top was secured with tape and the pot was left undisturbed.

Some leaves were placed in a larger terrarium and these were pressed into very loose peat moss and covered with a clear plastic dome for easy viewing.

I wasn't expecting this to work since the leaves turned an ugly brown within the next few weeks. But then I notice one leaf had tiny sparkling leaves ascending into the air. So to my surprise and joy, it worked! In fact it worked so well that I now have more than 20 new *D. dilato-petiolaris* plants!.

Suggested Reading

Kondo, K., Three new species of *Drosera L.* from Australia. Bol. Soc. Brot. ser 2, 57:51-60 1984.

Erickson, Rica. Plants of Prey. Lamb Publ. 1968.

WANT AD

Chas. Powell (2138 Harrison St., Santa Clara, CA 95050 USA) (Trade or Sell) *Nepenthes alata* - $15, tubers of *Drosera erythrorhiza* and *D. stolonifera* - $16, various *Sarracenia* species and hybrids - $4 ea., *Utricularia biflora* - $3 ea. and others in limited numbers. (Want-Buy or Trade) *Pinguicula vulgaris f. alpicola, P. vulgaris f. bicolor, P. balcanica, P. crystallina, P. hirtiflora, P. longifolia, P. vallisneriifolia* (I would like to correspond with anyone growing the European pings), *Utricularia unifolia, U. calycifida, U. nelumbifolia, U. endresii, U. praetermissa* (I would like to correspond with anyone growing large epiphytic bladderworts).

MIMICRY IN CARNIVOROUS PITCHER PLANTS — FACT OR LEGEND?

by Daniel M. Joel
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Newe Ya'ar Experiment Station, P.O. Haifa 31999,Israel

Patterns of shape and eolour together with taetile and olfaetory stimuli form guiding signals for insects in pitcher plants. Many parallels may be drawn between the mechanisms by which traps allure prey and those used by flowers to attract insects for pollination. It is often argued that the traps of carnivorous pitcher plants serve as mimics simulating properties of nectar-producing flowers (visual as well as olfactory), and that these properties attract flower-pollinators which are thus deceived, trapped and digested. In this way, according to Williamson (1982), the pitcher plants share the feature of capturing insects who have innate floral preference, or provision experience with flower models, but little or no experience with the trap.

This concept is widely accepted though having no experimental basis.

When reviewing the attraction mechanisms in carnivorous plants for our new textbook on these plants (Juniper, Robins and Joel 1988) I first found myself caught under the mimetic concept, but then gradually developed a growing suspicion towards it which led me to a thorough examination of the problem. As a result I have developed a new interpretation of the available information. Accordingly, a comprehensive review of the subject was recently published in the Botanical Journal of the Linnean Society (Joel (1988) and a whole chapter is devoted to this problem in our book. In the following I present the main points of the new concept.

What does mimicry mean?

Mimicry involves an organism (the mimic) simulating signals of another living organism (the model) which are perceived by a third living organism (the operator) as signals of interest, such that the mimic gains in fitness as a result of the operator identifying it as an example of the model (Vane-Wright 1980). When a rare, non-rewarding species mimics the more abundant 'provider', this deceptive mimetic system is classified as "Batesian Mimicry" (Pasteur 1982). The known deceptive mimics in the plant kingdom are mainly flowers, which interact with insects for pollination (Dafni 1984).

The supply of a compensating reward like nectar by the more common model is essential in order to subsidize the system. By definition, reward is never provided by the mimic.

Frequent deception will either lead to selective pressures against the mimic, or enable the operator to learn to avoid it. Hence, a successful mimic will build either scattered, small populations, or large populations which are active for a short while.

Do pitcher plants behave like mimics?

The traps of the carnivorous pitcher plants of the Sarraceniaceae, Nepenthaceae and Cephalotaceae do not fit important characteristics of a typical mimetic system.

Unfortunately, no study is available which compares insect pollinators and insect victms in the same habitat. Gibson (1983), who studied the North American pitcher plants, is of the opinion that certain species specialized in capturing insect taxa known to visit regularly non-carnivorous flowers blooming in the same habitat. Two points weaken the possibility of deceit mimicry in these cases. Firstly, there is often a temporal separation between the flowering period of associated flora and the trapping period of the pitchers. Secondly, pitcher plants are generally most active in capturing insects during their growth phase immediately after fire or drought when other flowering plants are far behind in forming their own community.

The populations of pitcher plants are often extremely large and dense. In certain species of *Sarracenia* they may attain phenomenal densities under regimes of repeated disturbances from fires, drought and heavy grazing. In these cases we may assume that certain insects, hatching in this same area, do not leave the boundaries of the pitcher plant population and are therefore attracted only to pitcher plants, not to neighboring plant communities.

All piteher plants are perennial, their traps being active for long seasons. Once a pitcher plant is established, it will provide a fairly regular supply of new pitchers over a number of years in a restricted area.

Extensive and dense stand of *S. leucophylla.* Photo by B. Hanrahan.

All these characteristics of the plant community of pitcher plants are not compatible with a deceptive status, and contradict a minetic strategy.

Perhaps the most significant feature of carnivorous pitcher plants which contradicts a mimetic status is their production of nectar, which is a real energetic reward. The traps of all pitcher plants secrete nectar, which is composed of a watery solution of sugar and is believed to contain amino acids as well. It is secreted mainly at the peristome and the hood. Nectar is very often also secreted on other parts of the pitcher, along the veins on the soutside of *Sarracenia* pitchers, along the 'fishtail' of *Darlingtonia* and along the 'wings' on the front of *Nepenthes* and *Cephalotus* pitchers.

The nectar secreted by pitcher traps is usually interpreted as an attractant, tempting insects to reach the trapping site and remain there until they stumble and fall into the digestive cavity where they are consequently digested. In flowers, nectar is regarded as an energetic and nutritional reward to pollinators. Likewise, extrafloral nectaries are supposed to support insects which confer services, like defense, to the plant. While visual and olfactory patterns of attraction are utilized both by traps and by deceptive mimetic flowers, nectar is not provided by floral mimics (Dafni 1984).

In many cases a large proportion of the insect visitors can be seen to consume nectar and leave the traps unharmed. This is particularly obvious in pitchers which are visited by ants. Traffic in two directions is often observed on these pitchers, which in indicative of the rewarding nature of their nectar. Surprisingly, the mean number of insects captured daily in a single pitcher is small in spite of the relatively high rates of visits per pitcher. For example, out of hundreds of ants visiting a *Cephalotus* pitcher every day only a few are consumed by the plant.

See **MIMICRY** on page 14.

MIMICRY continued from page 13.

Many insects manage to visit several pitchers during their stay in the pitcher habitat, and might also visit the same pitcher several times without being trapped.

The rate of insect capture, the structure of the plant community and, above all, the provision of nectar, rule out the possibility that pitcher plants adopted a mimetic strategy.

Instead, could mutualism apply to this system?

Mutualism is defined as an interaction between species that is beneficial to both (Boucher *et al*, 1982). The difference between mutualism and deceptive mimicry is in the bidirectional benefit of the former. Benefit is gained in the latter only by one side in the interspecific interaction. Perhaps the best example of mutualism in the plant kingdom is the interrelations between flowers and insect pollinators.

The data discussed above have lead me to suggest that pitcher plants resemble insect-pollinated flowers in that they serve as "nectar suppliers" in their habitats. In return, small portions of the insect communities, which benefit from the nectar provided by the pitcher plants, are 'sacrificed' and serve as prey.

This system can be mutually beneficial: The pitcher plants feed visiting insects with nectar, by which they support the insect community in their poor habitat where flowers and other sources of nectar are often uncommon or absent. The insects, in return, pay the plants with a small portion of their community which is trapped and digested. The plants, which commonly live in nutrient deficient habitats, benefit from the digested prey which provides an alternative source for certain absent soil nutrients.

The pitcher plants can provide sufficient amounts of nectar, because they grow in moist and sunny habitats where water supply and photosynthetic energy are not limited and thus the production of carbohydrate is relatively cheap.

Insects will return to the same pitchers or to similar pitchers if they have gained some profit during their first visit. They will rapidly learn that the visual and olfactory characteristics, typical of the pitchers in their vicinity, lead them to a reliable source of nectar. Those few insects which pay for the nectar with their lives cannot transfer their 'knowledge' of the possible danger, simply because they die. Selection against visits will not develop because the proportion of 'casualties' is limited.

Conclusion

Pitcher plants do not strictly mimic flowers; they resemble flowers. Both flowers and pitchers use insects for some sort of benefit, i.e. pollination and nutrition, respectively, and both pay the insects with energetic nectar. In evolutionary terms flowers and pitcher traps seem therefore to have formed convergent strategies.

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CARNIVOROUS PLANTS OF AUYANTEPUI IN VENEZUELA

Part 1

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In February 1988, I climbed the Auyantepui for the third time with some friends in order to study its vegetation and to collect living plants. The ascent was difficult and very exhausting because each time we had to carry all our food and equipment for the duration of our expeditions.

The Auyantepui has a height of 1700-2400 meters and surface area of about 700km^2, which is the largest of over 100 table-mountains of the Guyana Highlands. The word "Tepui" means mountain in the language of the Pemon-Indians who live in this part of the "Lost World". The Tepuis are relies caused by the partial erosion of a 3,000 meter high quartz-sandstone layer. The age of those sandstones, the so-called Roraima-Formation, is estimated at over 1000 million years. Although the Tepuis are separated from each other by extensive lowland plains, their lower layers often spread out as flat bases into the surroundings. In this way they form the typical terrace-like landseape of the Gran Sabana, as the southeastern Venezuelan Tepui land is called.

The larger parts of the Guayana Highlands are covered by rieh seasonal rainforests, interrupted by extensive, wide and barren "savannahs". Like islands in the sea, here and there a Tepui will rise dramatically a thousand meters into the sky. The climate of the lower altitudes differs strikingly from that of the plateau while the lowlands with their changing humidity are stewing in constant heat, the Tepuis are often bathed in cool fog.

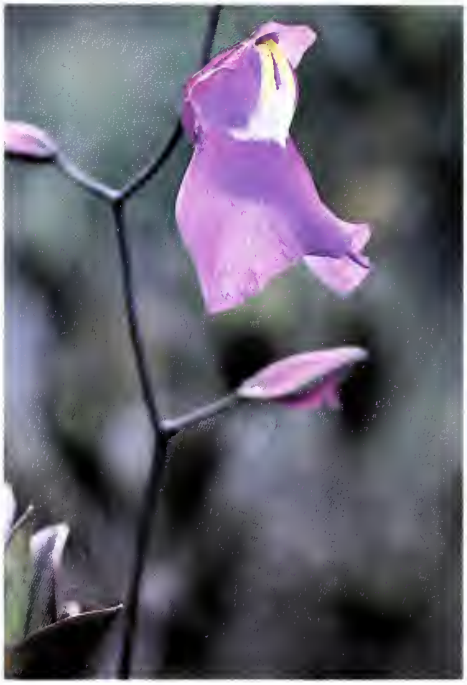
Since evolution of plant species took plaee on each rather isolated Tepui for a very long time, they are predominantly colonized by endemic organisms. The richly structured mesas offer very different biotopes such as bare rocks, alluvial sands, swamps, deep gorges, erevices, etc. resulting in a clear-cut mosaic of biocoenoses. Where there is enough soil, there grows a thiek, low mist-forest rich in epiphytes. Due to the acid soil, poor in nutrients, there are particularly many carnivorophytes in this area. Beside the legendary and attractive *Heliamphora,* arc a large variety of different *Utricularia, Genlisea* and *Drosera* species. Even Bromeliads are represented by at least two carnivorous species.

The notes below on ecology and occurence of observed carnivorous speeies may give some useful hints for their cultivation.

UTRICULARIA. In addition to the approximately 20 smaller, mostly amphibious species, I discovered 5 tuberous species with especially large and decorative flowers: *U. aspludii, U. jamesoniana, U. alpina, U. quelchii* and *U. campbelliana.* They grow at altitudes of 1000m or more and almost every night are moistened by fog.

U. jamesoniana is a small epiphyte which grows on slightly mossy and always shaded trunks and branches between 1000 and 2000m altitude on the slopes and terraces of the Tepui. At the same locations, I also saw *U. asplundii* which prefers vertical, mossy roek faces in half-shade and which dries up quickly after being moistened. Its graeile stalks bear up to 10 showy flowers 2em. in diameter. It can survive for longer periods of time under dry conditions due to its water-storing

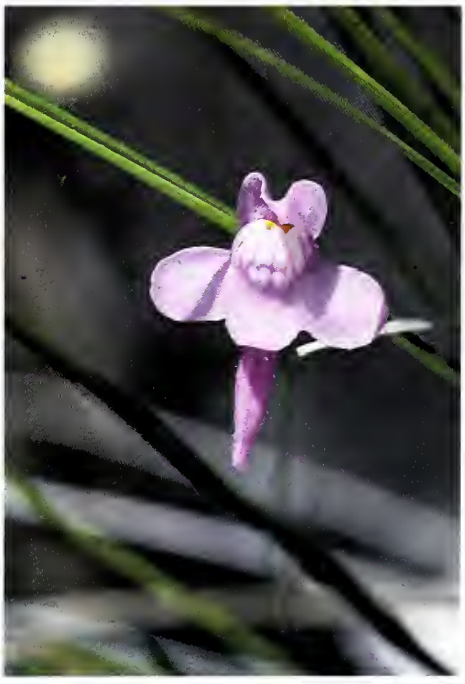
See text **VENEZUELA** on page 18. Photos pages 16 & 17.



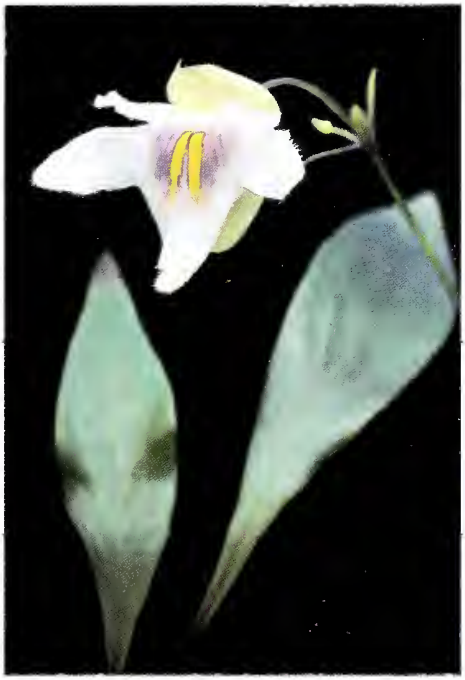
Utricularia humboldtii

Utricularia quelchii

Flower of *Brocchinia reducta.*



Unidentified *Utricularia* sp.



Utricularia asplundii

Utricularia jamesoniana

Below: *Brocchinia reducta* with fruits on foot of Auyantepui

VENEZUELA continued from page 15

tubers and shedding its leaves. *U. jamesoniana* and *U. asplundii* prefer somewhat higher temperatures than the following species: at night about 20°C, during the day up to 30°C.

U. alpina was found between an elevation of 1500 and 2000m on mossy tree-trunks in half-shade. *U. campbelliana* and *U. quelchii* are Tepui plants in the strict sense of the word and need to be cultivated at somewhat lower temperatures: at night about 16°C, daytime up to 26°C. Apart from the lower temperatures, *U. campbelliana* demands the same conditions as *U. jamesoniana.*

U. quelchii colonizes different habitats: vertical rock faces and tree-trunks covered with algae and mosses, open communities of mosses and lichens, bare peat and sphagnum, for the most part on oblique surfaces in half-shade.

All *Utricularia* species discussed so far have to be cultivated in small amounts of substrate which may occasionally be allowed to dry out slightly. They easily rot when constantly kept wet.

U. humboldtii is the largest species of the Genus. Its longstalked leaves are up to 40cm high and the flower scape may reach up to 1m. It has no storage tubers and it is without doubt adapted to live in the cups of Bromeliads, although it also grows in terrestrial populations in coarse peat. But nowhere else did I find them so beautifully developed as in *Brocchinia tatei, Brocchinia hechtiodes* and in dense colonies of *Orecanthe septrum,* an *Abolbodaceae* of bromeliad-like habitus. The fruit of *U. humboldtii* is globular and about 20mm long. At maturity, the stalk of the fruit dries out in its middle section. The capsule moves very easily in the wind, opens by a slit, and releases its large seeds in great numbers. At this stage, the already well-developed, green and folded embryo is enclosed by a transparent and winged membrane. Falling into a pool of water, the embryo unfolds within a few hours to a star-like seedling. The subsequently developed juvenile leaves are irregularly dissected into tender linear lobes, which is an adaptation for the beginning of aquatic life in the cistern of a Bromeliad. You can find all the transitional life-forms between those having juvenile "leaves" and those with "branches", but no transitional forms to the adult leaves. The wirey stolons grow in arches from one cistern into the other where they can develop bladders up to 10mm! This species flowers in my greenhouse every Spring with numerous 6cm large flowers. I grow them in coarse peat in plastic pots which sit constantly in shallow water. Although I found *U. humboldtii* on the plateau at 1800m and higher, it may also be cultivated in warmer eonditions.

GENLISEA. I found two of the 7 known species of the Guayana Highlands: *G. guayanensis* and *G. roraimensis.*

G. guayanensis is an aquatic plant of lower latitudes. At the tips of its 20cm long leaves and at the nodes of its flower stalks, it develops juvenile plantlets. It penetrates its large traps into the mud of puddles, ponds and slowly flowing waters. The water temperature is between 25-35°C.

G. roraimensis is a smaller species which populates several Tepuis. Mostly, it grows anchored in mud close under the water surface of shallow ponds and slowly flowing streamlets. The water temperature varies between 16°C at night and 30°C in the daytime. This species is autogamous and spreads only by seeds.

DROSERA. Of 11 recorded *Drosera* taxa, I was able to determine only 3 species for certain:

D. sessilifolia was found in the lowland savannah in open, sandy places. It looks in habitus and ecology very much like its closely related Asiatic species, *D. burmanni.*

D. esmeraldae is very abundant on the first terrace and on the mesa.

D. roraimae, often in dense colonies, grown on open, wet places on the mesa.

Most the of species discussed in this report are offered for sale or for an exchange of plants on the basis of equivalent rarity only. A free price-list is available from:

Dorothea Huber, Allmendstr. 28, CH-3014, Bern, SWITZERLAND

We cannot mail any *Genlisea* or *Utricularia* species to countries which only permit import of plants that are free of soil (for example, the U.S.A.)

A DETERMINATION OF GENETIC CONTROL FOR THE THIGMOTROPIC LEAF REACTION IN *DIONAEA MUSCIPULA*

by Eric Rosenberg
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The Venus' flytrap (**KINGDOM**-Plant, **PHYLUM**-Magnoliophyta (Angiosperm), **CLASS**-Magnoliopsida, **ORDER**-Sarraceniales, **FAMILY**-*Droseraceae*, **GENUS**-*Dionaea*, and **SPECIES**-*muscipula)* is a fascinating plant that has adapted to the nitrogen poor soil of bogs along the coastal areas of North and South Carolina. The Venus' flytrap has developed highly specialized leaves consisting of two lobes hinged at a midrib. When triggered the lobes close to catch insects and small animals that supply necessary nitrogen. These leaves can be closed when two of three trigger hairs, situated on the inner portion of the lobes, are stimulated within thirty seconds of each other.

Each trap has the ability to be triggered a certain number of times before it withers and dies. No two resources concur on the number of times each leaf can open and close before it is rendered useless. Is the number of times a leaf opens and closes before it withers a genetic trait? A procedure to test this point was developed.

The first step was to clone (make exact genetic duplicates) four "mother" plants into eighty daughter plants. Then, by testing the reaction of the clones, it would be possible to see if this trait is genetically controlled. How would this work? If all of the clones from one "mother" plant opened and closed the same number of times before withering, the trait can be concluded to be genetically controlled. A second possibility would be that all Venus' flytraps react the same number of times. This would again infer genetic control. Another option would be that this process was randomly determined.

The cloning process must be done in a sterile area because any contamination would surely kill the plants. To create this sterile area, a fish tank was placed on its side, and coated with isopropyl alcohol. The mother plants were placed in this sterile area, and separated in such a way that each clone had a bulb (enlarged base of the petiole) and a portion of the black roots. To separate these plants, sterile instruments were used. When the plants were successfully separated, each plant was either placed in air-tight sterile test tubes containing multiplication medium or rooting medium. The test tubes containing the clones were labeled according to their mother.

Careful records of the plants' growth and maturity levels were kept. Data included: the size of the plants, the size of their roots, and whether the plants' leaves were open or closed. After a period of about seven months, the plants were transplanted into soil. Plants were then removed from the safety of their sterile test tubes, and exposed to the soil of the outside world. The environment set up for each plant consisted of two clear plastic cups. One of these cups sat filled with soil, while the other gently rested inverted on top. This allowed the exchange of air, while retaining moisture. Each plant was placed equidistant from a flourescent light bulb, where they grew without interference for a period of two weeks. To assure the validity of the experiment all conditions were carefully monitored and kept identical for each plant.

The amount of times each leaf opened and closed before it dies was tested. Traps were stimulated at regular intervals under carefully monitored conditions. The number of times each trap opened and closed was recorded until the death of the leaf. This process took place over a period of four months. Schematic diagrams were kept and computers were utilized to assist the analysis of data.

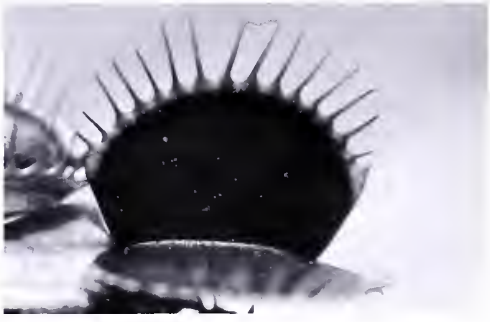
See **GENETIC** on page 20

GENETIC continued from page 19

The data followed what appeared to be a general pattern. All of the daughter plants from one parent did not have the same number of reactions. Different plants, and in many cases even different leaves of the same plant had different numbers of reactions. The number of times different leaves opened and closed ranged from one time to ten times. But, for most of the plants, the reaction for the leaves on the same plant was within two or three of each other. This pattern demonstrates that stimulus reponse limitation may be a genetic trait. In order to prove whether the number of times the traps of the Venus' flytrap open and close before withering and dying is genetically controlled, further data will be needed.

I would like to thank Joan Angerer and Wayne Seyfert for their support and assistance.

Eighty test tubes are arranged equidistant from a flourescent light.



Close-up of a Venus' flytrap. Note three trigger hairs on rear lobe. Photo by Bob Hanrahan.

TUBEROUS *DROSERA*

by Charles L. Powell II
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INTRODUCTION

Tuberous ***Drosera*** are unique among the sundews in forming an underground storage organ (referred to as tuber) to help the plants survive adverse conditions. These unusual plants are nearly all limited to the continent of Australia with the exception of *D. peltata* which is widespread in Asia from India east to Japan and from Australia north again to Japan.

Three forms of these plants are recognized based on the arrangement of their stems and leaves. These three forms are called upright (sometimes referred to as erect, climbing or scrambling) (Section *Ergaleium*), fan-leafed (Section *Stolonifera*), and rosetted (Section *Erythrorhiza*). The upright plants have an upright to decurrent stem with leaves which range from bell-shaped *(D. hugelii)* to shield-shaped *(D. peltata, D. auriculata)*. The upright group includes, among others: *Drosera auriculata, Drosera bulbigena, D. gigantea, D. heterophylla, D. hugelii, D. macrantha, D. menziesii, D. peltata* and *D. subhirtella*. The fan-leaf sundews are characterized by a stem which commonly branches near the base and has leaves which are fan shaped, included in this group are *D. stolonifera* (and all its subspecies), *D. platypoda, D. ramellosa,* and *D. fimbriata*. The third group form a basal rosette of leaves and look nearly identical to most common sundews. Included in the rosetted tuberous sundews are *D. bulbosa* (and the subspecies *major), D. erythrorhiza* (and all its subspecies), *D. macrophylla, D. rosulata, D. zonaria* and several new forms which are at present undescribed but are illustrated in Allen Lowrie's new book "Carnivorous Plants of Australia, Volume 1."

CULTIVATION

Tuberous *Drosera* are winter growers. As a result, when everything else is slowing down for the winter these plants put on a beautiful display. They are generally easy to cultivate if a few of their peeuliarities are observed. All tuberous *Drosera* require a dormant period. If forced to grow continuously the plants will most likely die, although a recent article by Tilbrooke (1988) indicated that some forms of *Drosera peltata* (not the west Australian form) can be kept growing continually if proper conditions are provided.

Soil medium — I have found that various mixtures of peat and sand are best for tuberous *Drosera*. Forms which require well-drained soil include *D. bulbosa, D. erythrorhiza, D. huegelii, D. macrophylla, D. menziesii, D. microphylla, D. macrantha planchonii,* and *D. stolonifera* (Pietropaolo and Pietropaolo, 1986). I use a peat-sand mixture of about 60:40 for these taxa. Forms which prefer a poorer drained medium, such as a peat-sand mix of about 80:20, include *D. bulbigena, D. bulbosa, D. gigantea, D. heterophylla, D. menziesii,* and *D. subhirtella* among others (Pietropaolo and Pietropaolo, 1986).

Water levels — During the growing season the pots containing these plants should be set in water. As the plant dies back in the spring, water is completely withheld until the soil medium starts to pull away from the sides of the pot. Depending on your summer conditions and the size of pot used, you may not have to water until growth starts again. The soil can be barely moist at depth in the pots during dormancy, although it is recommended that the pots go completely dry for several months. In your area you may not have to water the pot during the entire dormant season. If kept too wet during dormancy, tubers of many forms will rot.

Light — Tuberous *Drosera* appreciate high light levels. Only a minimum of shading appears needed, although light levels are generally much lower in the winter when these plants are in growth.

Temperatures — I have not had experience with these plants at temperatures below freezing, but in correspondance with Allen Lowrie he stated that the plants ". . . in the wild can withstand

temperatures down to about 1-5°C (circa 35°F) with no ill effects." My plants have experienced temperatures between 40°F and 110°F with no ill effects.

Dormancy — These plants need a dormant period! Dormancy may run up to about 8 months out of a year in some species. During dormancy I leave the plants in their pots and refrain from watering them. A few people have suggested taking the plants out of their pots and putting them in zip-top plastic bags. In California this hasn't worked for me as the tubers still dry out. But in milder climates, this may prevent the tubers from rotting in soil that is too wet.

PROPAGATION METHODS

The best way to begin experimenting with these plants is to obtain mature tubers of perhaps *D. peltata, D. auriculata* or *D. erythrorhiza* from other growers. After you have successfully grown these for a season or two you should try seed. The seed bank usually has one or two varieties to offer. The seed should be treated exactly as full grown tubers. Plant the seed in the fall and keep it wet until your new seedlings start to die back in the spring. Then withhold water until you see signs of life again. The seed does not always germinate the first year. If it does not, set the pot aside and the following season follow the above procedure again. Generally your patience will be rewarded by an abundance of seedlings. If by the second year nothing appears toss out the seed since it was probably bad.

Another method of producing new plants is by that old standby of *Drosera*-leaf cuttings. Although this does not work with all plants, such as the rosetted forms, I've had luck with some of the upright species. To date I have not tried leaf cuttings with any of the fan leaf sundews because the only one I grow is *D. stolonifera* and it produces abundant new tubers each season so I do not have to resort to other methods to propagate this species.

The last method for propagating tuberous *Drosera* involves doing nothing. If growing conditions are good, tuberous *Drosera* (particularly *D. peltata* and *D. stolonifera*) will produce extra tubers. For example, I recently unpotted a *D. stolonifera* and was rewarded with three fair-sized tubers where I had planted only one the previous winter. Since some species will not, even under the best conditions, produce additional tubers, you may have to resort to the methods discussed above.

CONCLUSIONS

When you receive dormant tubers you should immediately plant them. Keep the soil only barely moist to dry until you see signs of life — then set the pot in water (as always use *only* pure water). After a period of time the plants will start to die back; as they die back withhold water and don't water again (or only minimally if you live in a very warm climate) until you see signs of growth. Then the procedure should be repeated.

If starting from seed treat it identically to a mature tuber and give the seed two years to produce plants.

SPECIES DESCRIPTIONS

All the taxa here are easy to grow and should provide you with hours of enjoyment. I have grown all the species outlined here, but I have selected them for this article partly for their beauty, ease of growth, and partly because I have photographs to illustrate them.

Upright species

Drosera auriculata: This species is an upright form which is very similar to *D. peltata* and is even considered by some to be subspecies of it (Conn. 1981). It has shield shaped leaves and grows to about 30cm. It can be distinguished from *D. peltata* by the presence of spotted sepals (Conn. 1981). Two flower forms occur, one with light pink and the other with white flowers. This species is highly recommended for the beginner (fig. 1).

Drosera gigantea: This is the "king" of the tuberous *Drosera*. It can form large branching plants up to 1m high and nearly the same in width. The tuber, which can grow to 3cm across, can be found down to about 1m below ground level, making the entire plant about 2m high! The leaves are very similar to *D. auriculata* and *D. peltata*. However, the flower is different, making identifying immature plants that flower relatively easy. Without the flower, small plants are, for me, nearly indistinguishable from *D. peltata* or *D. auriculata*. But mature plants are so large and branching that they are easily recognized.

D. huegelii: A smaller species than the last, *D. huegelii* reaches a maximum hight of about 45cm (Lowrie, 1987), but is commonly less. Its few, bell shaped leaves make it easily recognizable. It has a beautiful white flower with totally reflexed petals (fig. 2).

D. menziesii: Three forms of this species are currently recognized (*D. menziesii* subspecies *menziesii*, *D. menziesii* subspecies *penicillaris* (n.n.), and *D. menziesii* subspecies *thysanosepala*). They are best differentiated by their flower, but there are also differences in the plants as a whole. For distinguishing features between these subspecies, the reader is referred to Lowrie (1987). In general this species is easy to grow and very tolerant of soil medium. It has a small tuber but can form quite a long plant, upwards of 115cm in *D. menziesii* subspecies *penicillaris*. The leaves look like a very shallow bell or bowl and are generally reddish in hue. Flowers are pink in *D. menziesii s.s.* and *D. menziesii* subspecies *penicillaris* and mainly white in *D. menziesii* subspecies *thysanosepala* although a pink form occurs.

D. microphylla: A moderate sized plant which grows up to 40cm, this species is easily distinguished by its orbicular leaves and distinctive flower. Flowers have dark red petals with golden-green sepals, making it one of, if not the most, distinctive *Drosera* flower (fig. 3).

D. peltata: This is perhaps the easiest tuberous *Drosera* to grow. It is nearly identical to, and possibly related to *D. auriculata* (see discussion under *D. auriculata*). The flowers of this species are always white (fig. 4).

Fig. 1. *D auriculata*.

Fig. 2. *D. huegellii*

Fig. 3. *D. nidrophylla*

Fig. 4. *D. peltata* grown by P. D'Amato

Fan-leaf species

D. stolonifera: Six distinctive forms of this species are currently recognized *(D. s. subspecies stolonifera, D. s.* subspecies *compacta, D. s.* subspecies *humilis, D. s.* subspecies *porrecta, D. s.* subspecies *prostrata (n.n.),* and *D. s.* subspecies *rupicola).* For distinguishing features the reader is referred again to Lowrie (1987). The leaves of all forms are generally ovate to spatulate and green to red in color, while the flowers of all forms are white. From one to several stems are produced on all forms except *D. s. porrecta,* which generally forms only a single stem when not in flower. In flower it develops side branches below the inflorescence. On the remaining subspecies the inflorescence rises from the center of the plant separate from the branches containing the leaves. This species, especially the nominal subspecies, is regarded as one of the easiest to grow and readily produces extra tubers after a successful growing season (fig. 5 and 6).

Rosetted species

D. bulbosa s.s.: There has been much confusion between this species and *D. rosulata.* According to Lowrie (1987) *D. bulbosa* can be distinguished from *D. rosulata* by the former's "golden-yellow lamina when mature; the raised ridge along the length of the middle of the leaf and the lack of black dots on the sepals." *Drosera bulbosa* also has white pollen, while on *D. rosulata* it is yellow. A large pale green to reddish form is known as *D. bulbosa* subspecies *major* (fig. 7).

D. erythrorhiza: Four forms of this species are recognized: *D. e.* subspecies *erythrorhiza, D. e.* subspecies *collina (n.n.), D. e.* subspecies *magna (n.n.),* and *D. e.* subspecies *squamosa.* They form rosettes between 6 and 12cm in diameter. The leaves are generally green, but *D. e. squamosa,* displays a red border. The flower of all the forms is white. The nominal subspecies *(D. erythrorhiza erythrorhiza)* is an easy plant to grow and is highly recommended for beginners (fig. 8).

See **TUBEROUS** on page 26

Fig. 5. *D. stolonifera* ssp. *stolonifera.*

Fig. 6. *D. stolonifera* ssp. *stolonifera* in flowers.

Fig. 7. *D. bulbosa.*

Fig. 8. *D. erythrorhyza ssp. erythrorhyza.*

TUBEROUS continued from page 24

D. rosulata: This species is very similar to *D. bulbosa,* as discussed above. It has a very pretty medium green rosette and I have found it flowers abundantly. This too, is a very easy species to grow and is again recommended for beginners if you can find it (fig. 9).

I would like to thank Allen Lowrie who helped greatly with this article and Mary McGann for reviewing the article and adding her helpful criticism. I would also like to thank the editors of CPN for their help.

Fig. 9. *D. rosulata* in habitat - Badgingarra, Western Australia. Photo by P. Mann.

COMING IN JUNE, 1987

- CP of Auyantepui Part 2
- CP in 3-D: Take 2
- Early history of *Drosera* & *Drosophyllum*

WANT AD

Buy *Drosophyllum* plants and send prices to: Neil Boby, P.O. Box 74, Wendel, PA 15691. Please send me cultural information on *Drosophyllum* plants.

LITERATURE REVIEW

Karlsson, P.S. Seasonal patterns of nitrogen, phosphorus and potassium utilization by three *Pinguicula* species. Funct. Ecol. 2(2): 203-210 1988.

In Scandinavia, *P. alpina* grows on calcareous soils, *P. villosa* on nutrient-poor bogs and *P. vulgaris* is widely distributed. Flowering plants allocate about 45% of nutrients to sexual reproduction in *P. alpina* which is the lowest and about 65% in *P. villosa* which is the highest. In general, flowering plants lost a larger fraction of their nutrient pool than non-flowering (68% versus 42%).

Muravnik L.E., The slime gland ultrastructure in *Pinguicula vulgaris* (Lentibulariaceae) in the course of their development and function. Bot. Journ., Leningrad, 73: 1523-1535, 1988. (Russian.)

The continual secretion in slime (stalked) glands is realized by means of Golgi apparatus, a highly developed endoplasmic reticulum. Polysaccharide mucilage component is transferred into the slime layer of the secretory cells, which serves as a storage before mucilage discharge into the gland surface through the discontinuities of the cuticle. The stimulation of the leaf by protein substrate does not exert any effect on the slime glands, in contradiction to the sessile (digestive) glands (see previous papers of the same author: Vassilyev and Muravnik, Bot. Journ. 71: 1050-1059, 1986; Muravnik, Bot. Journ. 73: 24-33, 1988, (Russian, English summary)).

Naeem, S. Resource heterogeniety fosters coexistence of a mite and a midge in pitcher plants. Ecol. Monogr. 58(3): 215-227 1988.

Darlingtonia californica, the California pitcher plant traps insects and the decomposing mass becomes food for two competing insect species. *Sarraceniopus darlingtoniae*, a slime mite, and larvae of *Metriocnemus edwardsi*, a midge, consume food at different rates. The midge larvae consumed resources at a greater rate and the densities of the two species are negatively correlated. There is a tempororal and spatial heterogeneity in resources. Coexistence of the two species occurs when resource levels are above expected levels. Differences in population desities occur when resources are less than expected.

Ownbey, BO and WR Smith, 1988. New and noteworthy plant records for Minnesota. Rhodora 90:369-377.

Among several new plant records for the state was *Utricularia resupinata*. They are approximately 100 miles from the nearest sites in Thunder Bay and in Wisconsin. They were found in Lake County in flower in mid-August.

Santos, E. 1986. O genero *Drosera* L. no Brasil. I-Una nova especia. Bradea 4:305-308. (In Latin and Portuguese).

A new species of sundew, *Drosera pumile*, is described from Mato Grosso in Brazil. It resembles *D. bravifolia* but has a taller, even more hirsute peduncle, different stipule morphology, and leaves with petioles and of spathulate shape. A line drawing is included in the paper.

Thor, Goran The genus *Utricularia* in the Nordic countries, with special emphasis on *Utricularia stygia*, a new species and *U. ochroleuca*. Nord J. Bot. 8(3): 213-225 1988.

This paper describes the genus *Utricularia* in the Nordic countries with emphasis on the above named species. The author describes all species with two different taxonomic keys: one using only the four-armed hairs called quadrifids found inside the bladders and the other by the flowers. The length of the spur and its angle defines the above two species and distinguishes it from *U. intermedia*. *U. stygia* as a new species differs from *U. ochroleuca* by having a darker yellow, larger, almost flat lower lip and slightly larger number of teeth with bristles on each leaf segment. *U. ochroleuca* has paler, smaller flowers with a lower lip which is almost flat but later the margins become deflexed.

THE 1989 LIST OF CP BOOKS

Not available through CPN. Order directly from publisher, your local bookshop or C.P. Nursery.

* = Books intended primarily for children.

☐ = Books out-or-print.

1. *Animals & Plants that Trap by Phillip Goldstein. Holiday. 1974; Holiday House, Inc.; 18 E. 53rd St.; New York, NY 10022. $5.95.
2. Carnivorous Plants by Gordon Cheers. Globe Press, Melbourne. World Insectivorous Plants; P.O. Box 70513; Marietta, GA 30007; USA. $7.00.
3. Carnivorous Plants by Francis E. Lloyd. Peter Smith; 6 Lexington Ave., Magnolia, MA 01930; USA. 1942 ed. Paper $7.95 from Dover Publications; 31 E. 2nd St.; Mineola, NY 11501. Or: World Insectivorous Plants; P.O. Box 70513; Marietta, GA 30007; USA. $8.00.
4. Carnivorous Plants by Randall Schwartz. Avon Books, 1975; 959 Eighth Ave.; New York, NY 10019; USA. Soft cover $1.25.
5. Carnivorous Plants by Adrian Slack. MIT Press, 1979; 28 Carleton St.; Cambridge, MA 02142; USA. 1980 ed. $28.00. 1984 paper $12.50. Or: World Insectivorous Plants; P.O. Box 70513; Marietta, GA; USA. Paperback $12.50.

☐ 6. Carnivorous Plants by John F. Waters. Franklin Watt, Inc., 1974; 845 Third Ave.; New York, NY 10022; USA. $4.90.

7. *Carnivorous Plants by Cynthia Overbeck. Lerner Publications, 1982; 241 First Ave.; Minneapolis, MN 55401; USA. $12.95.
8. Carnivorous Plants of Australia. Vol. 1. by Allen Lowrie. West Australia Univ. Press, 1986; Nedlands, WA 60009; AUSTRALIA. Or: International Specialized Books; 5602 NE Hassalo St.; Portland, OR 97213; USA. Paperback $32.50; hardback $45.00. Plus $2.25 UPS.
9. Carnivorous Plants of the World by J. & P. Pietropaolo. Timber, 1986. Peter Pauls Nurseries; Canandaigua, NY 14424; USA. $30.30.
10. Common Marsh, Underwater & Floating Leaved Plants of the United States & Canada by Neil Hotchkiss. 1972. World Insectivorous Plants; P.O. Box 70513; Marietta, GA 30007; USA. Paperback $8.00.
11. CP of the US & Canada by D.E. Schnell. John F. Blair, Publisher. 1976. 1406 Plaza Dr., SW; Winston-Salem, NC 27103. 1976 ed. $9.50 + shipping.

☐ 12. Cultivating Carnivorous Plants by Allen Swenson. Doubleday & Co., 1977; Garden City, NY 11535; USA. $7.95.

13. *Insect-Eating Plants by L. & G. Poole, T.Y.Crowell, 1963; 666 Fifth Ave.; New York, NY 10016; USA. $4.50.
14. Insect-Eating Plants and How to Grow Them by Adrian Slack. 1986. University of Washington Press, P.O. Box 50096, Seattle, WA 98145. $19.95.
15. Insectivorous Plants by Charles Darwin. AMS Press, 1893; 56 E. 13th St.; New York, NY 10003; USA; Vol. 12, 1972. $42.40.
16. *Nepenthes* of Mt. Kinabalu (in English) by S. Kurata. Sabah National Park. World Insectivorous Plants; P.O. Box 70513; Marietta, GA 30007. USA. $10.00.
17. Pitcher Plants by Carol Lerner. William Morrow & Co.; New York. $11.00.
18. Pitcher Plants of Peninsular Malaysia & Singapore by Roger G. Shivas. Maruzen Asia Pte. Ltd.; 51 Ayer Rajah Crescent #07-09; Singapore 0531. $10.50.

☐ 19. Plants of Prey in Australia by Rica Erickson. Univ. of W.A. Press, 1986.

20. *Plants That Eat Animals by J.H. Prince. Lodestar Bks.; 2 Park Ave.; New York, NY 10016; USA; 1979 ed. $8.95.
21. The Carnivorous Plants by B.E. Juniper, R.J. Robins and D.M. Joel. Academic Press, Book Market Dept., 1250 Sixth Ave., San Diego, CA 92101. Tel. 1-314-528-8110. $150.00

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Name and Address	Catalog Price	Stock
Alain Christophe 37, Avenue Turgot Oxoir-la-Ferriere F-77330 France	$7s	S. African *Drosera* seed
Burleigh Park Orchid Nursery Ian & Pat Walters 1419 Ross River Rd. Kelso, Townsville QLD 4815 AUSTRALIA 077 74008		*Nepenthes*
Carolina Exotic Gardens Rt. 5, Box 283-A Greenville, NC 27834 USA 919/758-2600	$1.00	*Darlingtonia, Dionaea, Drosera, Pinguicula, Sarracenia,* live *Sphagnum* moss
Cedar Ridge Nurseries R.D. #1, Cedar Ridge Rd. Allison Park, PA 15101 USA 412/443-9073	Free	*Nepenthes*
Cyril G. Brown 65 Highfield Cres. Hornchurch Exex. RM 126 PX ENGLAND		
Glasshouse Works Church St, Box 97 Stewart, OH 45778 USA	Free	*Nepenthes*
Harold Weiner Kaiserstr. 74 Hamelin I D-3250 WEST GERMANY	Inquire	*Aldrovanda, Byblis, Cephalotus, Dionaea, Drosera, Drosophyllum, Nepenthes, Pinguicula, Sarracenia*
Heldon Nurseries Ashbourne Rd. Spath Uttoxeter ST145AD ENGLAND		
Hinode-Kadan Nursery 2735 Nakanogo, Hacijyot Hachihyo-Island Tokoyo 100-16 JAPAN	International Reply Coupon	*Byblis, Cephalotus, Drosers, Pinguicula, Nepenthes, Utricularia*

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ISRA Exotics P.O. Box 1200 BSB Brunei: BORNEO	Free	*Nepenthes*
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Orgel's Orchids Rt. 2, Box 90 Miami, FL 33187 USA 303 233-7168	Free	*Byblis, Dionaea, Drosera, Nepenthes, Pinguicula, Sarracenia, Utricularia*
Peter Pauls Nurseries Canandaigua, NY 14424 USA 716 394-7397	Free	*Darlingtonia, Dionaea, Drosera, Nepenthes*, seed, *Pinguicula, Sarracenia, Utricularia*, live *Sphagnum*
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Roy Young 79, Pearcroft Rd. Leyton Stone London E11 44P ENGLAND 01 556-8048	1 International Reply Coupon	Seed of CP
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South West Seeds Dough & Vivi Rowland 200 Springs Rd. Kempston, Bedford MK428ND ENGLAND		

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W.T. Neale & Co., Ltd. B.M. & S. Lamb 16/18 Franklin Rd. Worthing, Sussex BN132PQ ENGLAND	Inquire	*Darlingtonia* seed, *Dionaea, Sarracenia*
World Insectivorous Plants P.O. Box 70513 *Marietta, GA 30007* USA 404/973-1554	$1.00	*Cephalotus, Dionaea, Drosera, Nepenthes, Pinguicula, Sarracenia, Utricularia*

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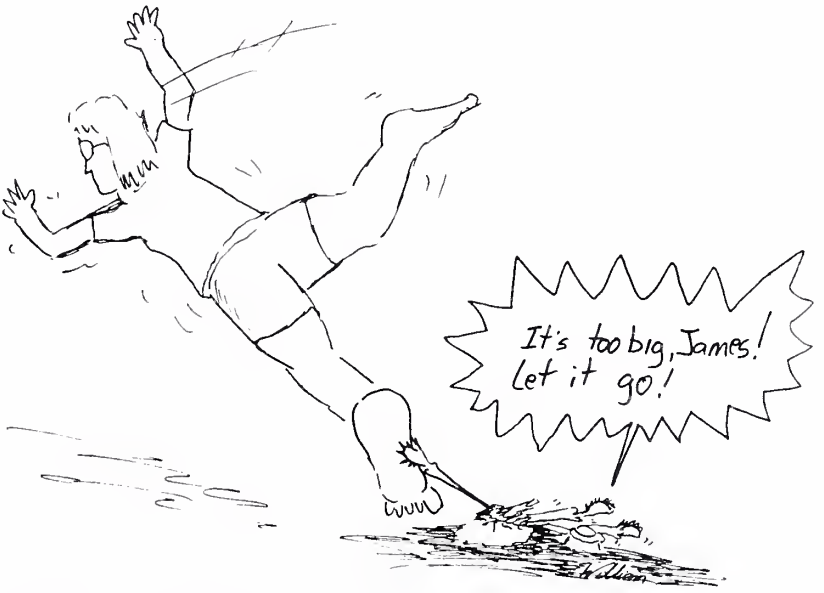
TIDBITS
from Bill Strand



This small, night-active frog inhabits the tubes of *Brocchinia reducta* on Auyantepui, Venezuela.